RELATIONSHIPS BETWEEN WINTER AIR TEMPERATURE OVER SOUTH-WESTERN EUROPE AND ATMOSPHERIC CIRCULATION

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1. BACKGROUND

- The dominant modes of atmospheric circulation over the Northern Hemisphere have shown to be associated with winter temperature variations over south-western Europe.
- The spatial and temporal variations of winter temperature have been separated to identify causal mechanisms responsible of the potentially predictable seasonal signals.

2. CORRELATION BETWEEN CIRCULATION INDICES AND WINTER TEMPERATURE

- The correlation between observed temperature and indices such as the Arctic Oscillation, the North Atlantic Oscillation, the East Atlantic, and the Southern Oscillation provides an estimate of the association and the potential predictability of temperature anomalies.
- For the period 1970 to 1995, the East Atlantic (EA) pattern influences most regions of south western Europe (Figure 2). While the East Atlantic regime dominates, higher than normal temperatures may be expected over south-western Europe. Although EA is not a frequent mode of Atlantic circulation, it has an important impact on temperature variations over the whole region.
- The North Atlantic Oscillation and the Arctic Oscillation show positive correlation in France, and negative correlation in southern Spain and northern Africa. Most of the British Peninsula is in the transition zone from positive to negative correlation.
- The Antarctic Southern Oscillation Index could contribute to some temperature variations in the northeast of the British Peninsula (weak correlation).

3. MODES OF WINTER TEMPERATURE VARIABILITY

- In order to analyze the temporal behavior of temperature, we have reduced the dimensionality of the time series by applying linear principal component analysis using the detrended time series.
- Figure 3 shows the eigenvalue spectra, which inform us about the number of modes to retain, and about their degeneracy.
- Figure 4 shows the unrotated and rotated empirical orthogonal functions:
  - The unrotated modes resemble better the correlation maps between the circulation indices and temperature field than the rotated ones.
  - The rotated modes are separated and more stable than the unrotated ones.
- The correlation coefficients between the principal components of the temperature field and the teleconnection indices are higher for the unrotated EOFs (Table 2).

4. CIRCULATION REGIMES AND PREFERRED MODES OF TEMPERATURE VARIATIONS

- The temperature Empirical Orthogonal Functions (EOFs) could be interpreted by:
  - obtaining the correlation between each principal component or coefficient of the temperature field and the gridpoint geopotential (the 700 hPa level has been used). The figure 5 shows the first principal component of the temperature field, which resembles the East Atlantic pattern. It represents the NAO or AO structure, and could be a negative phase of NAO with meridionally deformed westerlies.
  - composing maps for extreme values of some circulation indices. An example is shown for extreme NAO values. When the NAO regime is in its positive phase, winters are warmer in France but northerly flow occurs across the Mediterranean, which cools south-eastern part of the peninsula. The figure 6 (bottom) illustrates this effect.

5. SPECTRAL ANALYSIS

- The first principal component shows a signal at about 7 years (Figure 7a).
- The second principal component shows signals in the bands of quasi-decadal, quasi-quartuennial and quasi-biennial years. The quasi-decadal and quasi-biennial variations are also detected in the North Atlantic Oscillation (Figure 7b).
- The third Principal component accounts for interdecadal (Section 7c), interannual variations involving changes in ocean circulation. We have obtained significant ENSO for the third mode of temperature variation.
- The signals of about 8 and 4 years in PC2 and NAO are near to the 95% significance level. The signal of about 8 years prevails to be quite persistent, as can be observed in the windowed spectra (Figure 8) for different time realizations. The 8-year oscillations show high coherence since 1950’s.

6. CONCLUSIONS

- The winter temperature field has been broken down into spatial and temporal modes.
- The modes were associated with the atmospheric circulation patterns: EA, NAO and AO indices were the most influential on winter temperature variations.
- The association has been obtained in spatial and time domains.
- The winter temperature field could be reconstructed by considering the relationships with the circulation indices.
- The results of this research are being experimented for potential temperature predictions.

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Table 1: DATASETS

Table 2: Correlation between circulation indices and winter temperature

Figure 1: Mean and anomaly temperature patterns.

Figure 2: Correlation between indices and temperature patterns.

Figure 3: Spectra of temperature, EA and NAO indices.

Figure 4: Spectral analysis of circulation patterns, EA and NAO indices.

Figure 5: Spectral analysis of circulation patterns, EA and NAO indices.

Figure 6: Spectral analysis of circulation patterns, EA and NAO indices.

Figure 7: Spectra of temperature, EA and NAO indices.

Figure 8: Spectral analysis of circulation patterns, EA and NAO indices.

Figure 9: Spectra of temperature, EA and NAO indices.